SUGGESTIONS FOR A PRACTICAL COURSE IN HIGH-SCHOOL BOTANY

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High-school science courses should be so organized with reference to content that they will meet the needs of the pupil in ordinary life rather than in advanced study. High-school teachers should realize that they must break away from tradition and college-entrance requirements, so far as these are restraining factors, and organize a body of knowledge that shall have as its purpose the study of common things in order that the pupil may live more efficiently. The opposition of higher educational institutions to such a development is rapidly disappearing. Today some of the pronounced advocates of the reorganization of high-school science courses are eminent teachers of science in colleges and universities. Among these are such men as Professor C. R. Mann, Professor O. W. Caldwell, and Professor J. F. Woodhull. It seems settled that diluted college science is not what should be given the average boy or girl as a preparation for life. Indeed, there is a growing belief that it is not the best thing even for the pupil who goes on to advanced work.

There is no inherent reason why an "applicable" course in any high-school science should be a "soft" course. The fact that any phase of a subject is practical does not prevent it from demanding serious study. In fact, the hardest and most absorbing work on the part of high-school pupils that it has ever been the privilege of the writer to witness has been done in connection with the practical phases of their science work.[1]

All students should carry away from a high-school course in botany an intelligent interest in plant life and an apprecia-

[1] The course in applied chemistry given in the Menomonie High School was described by Mr. Works in the *School Review* for October, 1910, pp. 560–64.

tion of some of the many important ways in which it touches their own daily lives. Several years of experience in elementary science teaching with pupils who were high-school graduates convinced me that this is not ordinarily the case.

With the foregoing ideas more or less clearly defined, a definite attempt has been made in the Menomonie High School to develop a course of botany in which particular stress is laid upon the economic phases. The work as administered in the past has covered a period of twenty-four weeks and has been required in all courses. As is the custom in most schools in Wisconsin, the subject comes in the second year of the high school, so that the pupils range from fourteen to sixteen years of age.

The following outline will give an idea of the principle economic phases upon which stress is laid. Within the limits of this article it is, of course, impossible to cover the course in detail. The rather detailed outline on bacteria will give a general idea of how the other subjects are treated.

Three to four weeks are devoted to the work in elementary bacteriology. This part of the course has been found helpful, giving pupils an intelligent attitude toward many of the problems of home and public sanitation. By this elementary study of bacteria the foundation can be laid for rational co-operation with health authorities with reference to public sanitation and infectious and communicable diseases.

The following topics receive consideration: occurrence, structure, reproduction, conditions favorable for growth, and some results of growth. Experimental work is used to illustrate as many of the topics as possible. Some of the experiments that have proved very satisfactory with our pupils are the hay infusion experiments, tests to show the presence of bacteria in the air under varying conditions, to detect them in water and milk and on the body, and to show conditions favorable for growth. Sterilization and disinfection are illustrated. This work is followed by a study of the economic importance of bacteria in the household and on the farm, and, necessarily in an elementary way, of their relation to disease. The "pure" phases of the

subject are determined largely by the practical applications that are to follow. Throughout the course care is taken not to lead the pupil blindly to the applications. In presenting this work and throughout the course the compound microscope is used when it will contribute to the intelligence with which the pupil works. If the use of the instrument degenerates into abuse it is because of lack of judgment on the part of the teacher.

Because of local conditions a study is made of blue green algae in their relation to pollution of water supply. The water for Menomonie is drawn from a small lake near the city, and abundance of illustrative material may be obtained by straining the water as it flows from a tap in the laboratory. The study of the structure of the water system together with a consideration of the conditions favorable for the growth of blue greens and the knowledge the pupils already have of bacteria puts them in a position to understand the danger of using the water. Methods of treating such water so that it may be used for drinking purposes without danger are taught.

The method of treatment of yeasts resembles materially that described for bacteria. The usefulness of the yeasts is sufficient to justify a somewhat detailed consideration.

The fungi offer such an abundance of material that care has to be exercised in the selection. The forms which we have found best adapted to our purposes are the following:

1. The blights are approached through a study of lilac blight. Material it easy to obtain and is sufficiently large to be handled in a satisfactory manner. A study of the life history of this form puts the pupil in a position to understand the significance of the spraying of fruit trees.

2. Mucor serves as a basis of the work with the molds that are of importance in the household. The study of the life history and conditions favorable for growth and reproduction enables the pupil to appreciate intelligently the means of preserving our food from the action of molds by drying, use of chemical preservatives, low temperature, and high temperature followed by hermetical sealing.

3. A careful study is made of the smuts and rusts of grains.

A method of treatment similar to that indicated for blights serves as a basis for a discussion of the methods of treating grain smut. The attention of the students is directed to the efforts that are being made to develop rust-resistant grains.

4. A brief study of the higher fungi is made and the economic importance of the bracket fungi and the mushrooms is brought out.

In the study of flowering plants the practical phases are made prominent throughout the work. The study of seeds naturally leads to seed testing and selection and to the study of food materials derived from a few typical grains. In connection with seed and fruit distribution use is made of the excellent opportunity that occurs for study of noxious weeds. This subject is supplemented in connection with the work on underground stems.

Some of the important commercial products derived from stems, such as turpentine, resin, camphor, and rubber receive attention at the time the study is made of the stem. Careful study of the practical applications in agriculture and horticulture are made in connection with such topics as grafting, transplanting, trimming, and proper methods of treating tree injuries. At all times the paramount idea is to have the pupil understand enough of the botany to comprehend and appreciate the practical side of the work.

In addition to the economic phases that are considered in connection with the regular work of the subject a few topics are considered of sufficient importance to justify separate consideration. This list includes an intensive study of a few farm plants, such as the potato, corn, and one of the small grains; elementary forestry; and plant breeding.

The work has been carried out most satisfactorily when the recitation, laboratory, and field work were supplemented with talks by the instructor which served as a preparation for the student when a new topic was taken up. Liberal use is made of bulletins from the United States Department of Agriculture and from the state experimental stations. These bulletins have proved to be extremely valuable.

Botany perhaps more than any other high-school science has

suffered from an over-burden of scientific terms. Teachers have often deceived themselves by thinking pupils were making real progress in the subject because they were learning new terms. They have mistaken the shadow for the substance. Often a pupil may learn the term without mastering the idea. Pupils should not be allowed to grope about using bungling expressions because of lack of proper technical terms: every scientific term essential for progress should be mastered. But we have found that it is possible to reduce greatly the number of terms that are used in the ordinary text in botany. This together with the use of English words or compounds instead of foreign derivatives has materially simplified the terminology.

With the teacher well prepared for the subject it seems to be a matter of minor importance as to just how the approach to the subject is made. The statement of Professor John M. Coulter seems very fair:

> The prepared teacher also means the ability to attack the subject in a variety of ways. There is no ideal method of first attack, for it may well vary, dependent upon many circumstances. Botany is like a great park, whose approaches are numerous. The most natural one to use is the one that happens to be most convenient at the time, the one nearest to the pupils. This means considerable grasp of material and great flexibility in presentation. A teacher who only knows one way is singularly handicapped. The principle just stated convinces me that it would be very unfortunate for any committee to assume to determine that some one method of approach is the best. This is to be determined by the competent teacher, whose special problem it is. It is certainly a waste of time to answer such a question for the incompetent teacher. The final application of power must be made by the teacher, and anything that encourages initiative in this respect is so much clear gain.
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> The prepared teacher also means the disappearance of the well-worn excuse of difficulty in reference to any approach. Every approach is easy for him who knows the way; and to those who are under competent guidance every approach is equally easy. I have used every group of plants and every aspect of plants as the initial point of attack, and I have found them all equally easy to pupils, and I have also found pupils equally ignorant of all of them. The excuse of difficulty always means the unprepared teacher. Botany is never difficult when taught by the prepared teacher; it is always difficult and futile when taught by one who is unprepared.[2]

[2] Cf. John M. Coulter, "Botany," *School Science and Mathematics,* IX (April, 1909), 362–67.

Frequently the statement is made that practical courses in the high-school sciences are lacking in balance. For two reasons I do not care to defend this course against such a charge, (1) We have attempted more in most high-school courses in botany, I believe, than it was possible for students to handle in a satisfactory manner. We have not been able to furnish a motive for much that we have attempted in the subject and have left our pupils bewildered and without an abiding interest in a very important subject. (2) Our course has been developed to meet the needs of pupils living in a distinctly rural community and attending an institution in which all pupils are required to take at least two years of industrial work. This makes possible some correlations that might not be possible in every school.